



GSSC/HEASARC/GCN

GS SDR Section 14

Robin Corbet/Tom Stephens/Dave Davis/David Band



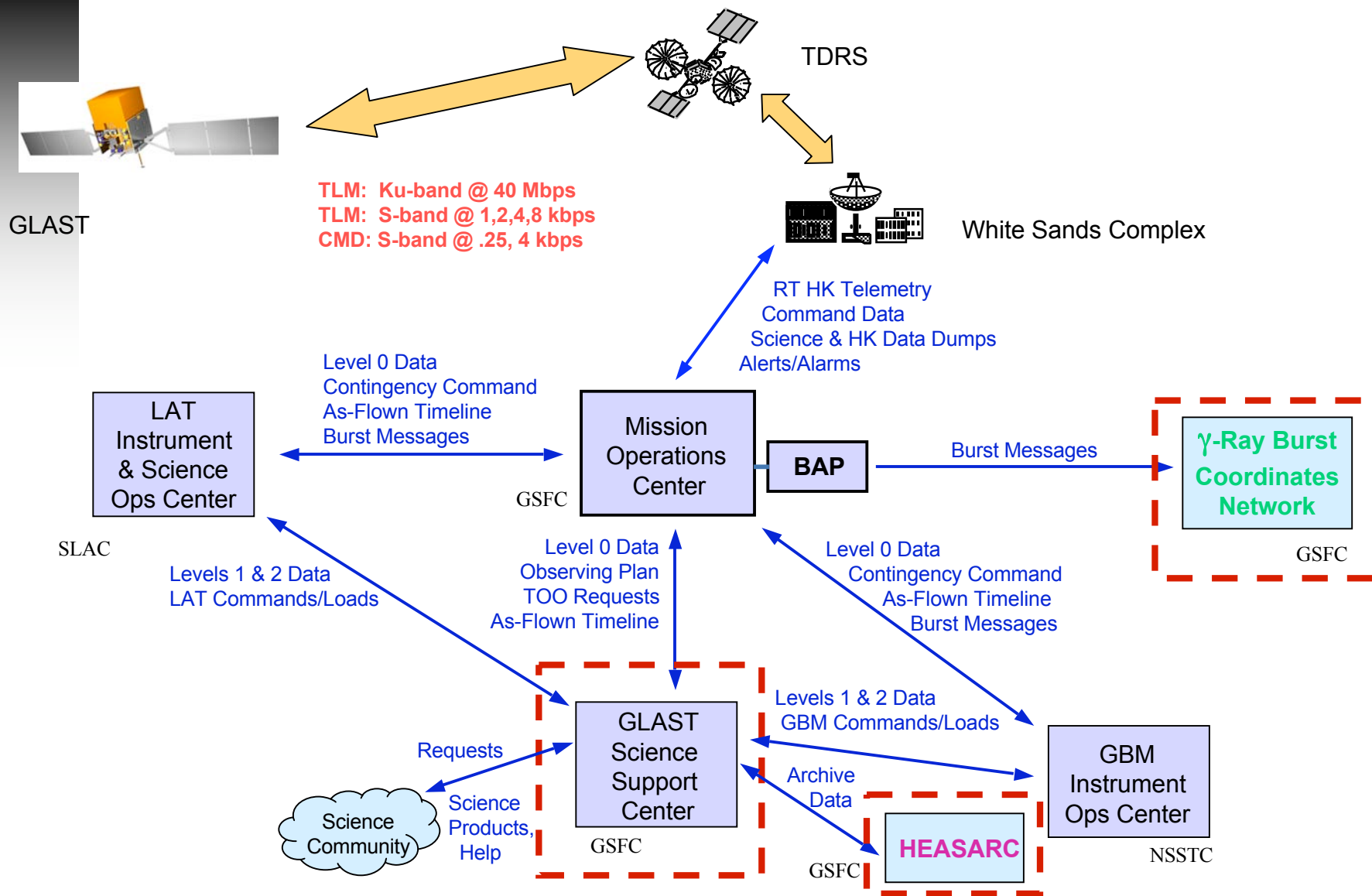
GSSC / HEASARC / GCN Outline



- | | |
|-------------------------------------|--------------------|
| 1. <i>Organization / Overview</i> | <i>R. Corbet</i> |
| 2. <i>Operations</i> | <i>R. Corbet</i> |
| 3. <i>Pipelines</i> | <i>T. Stephens</i> |
| 4. <i>Data Archive and Software</i> | <i>D. Davis</i> |
| 5. <i>User Support</i> | <i>D. Band</i> |
| 6. <i>Testing</i> | <i>T. Stephens</i> |

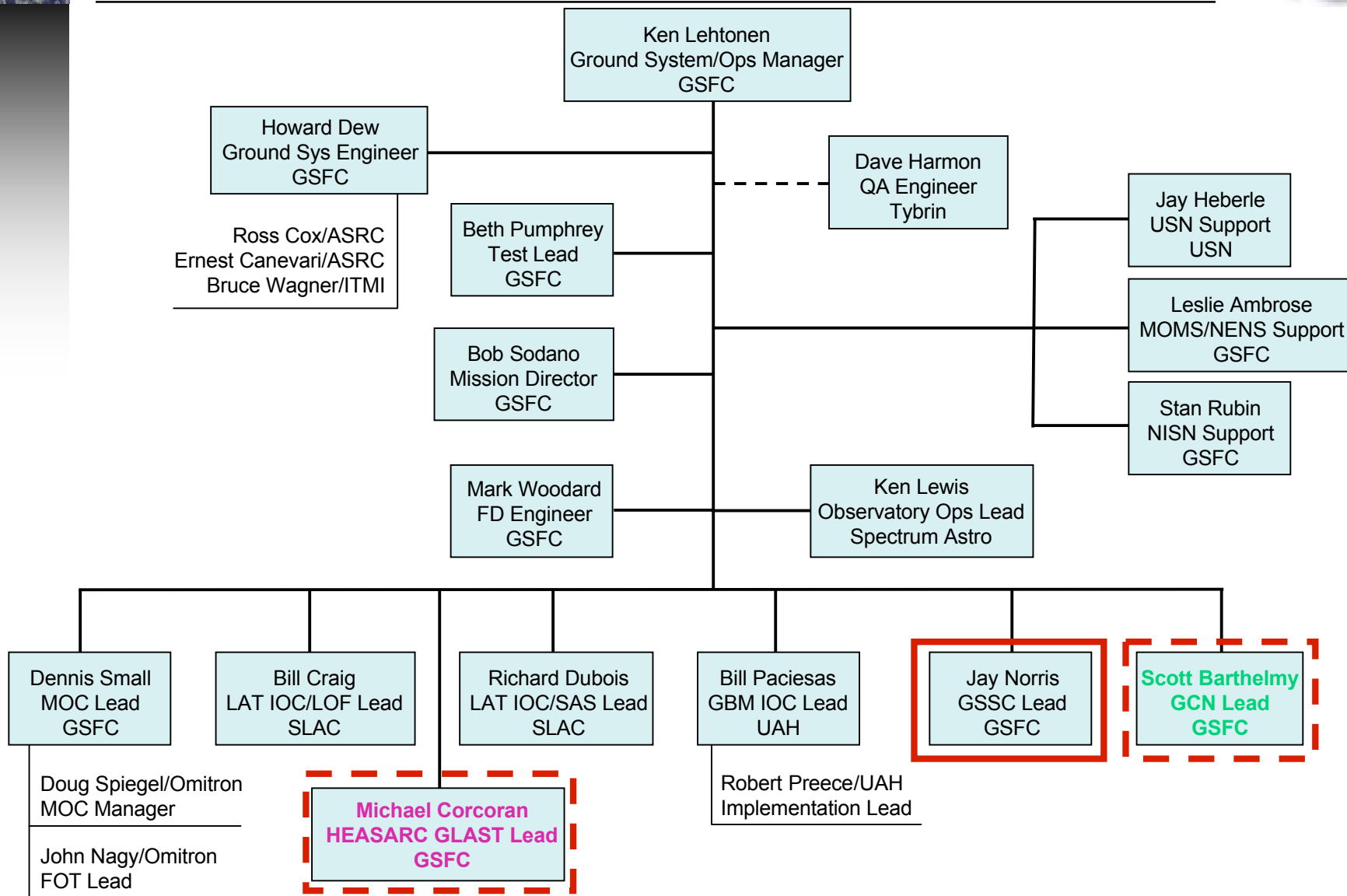


Mission Architecture



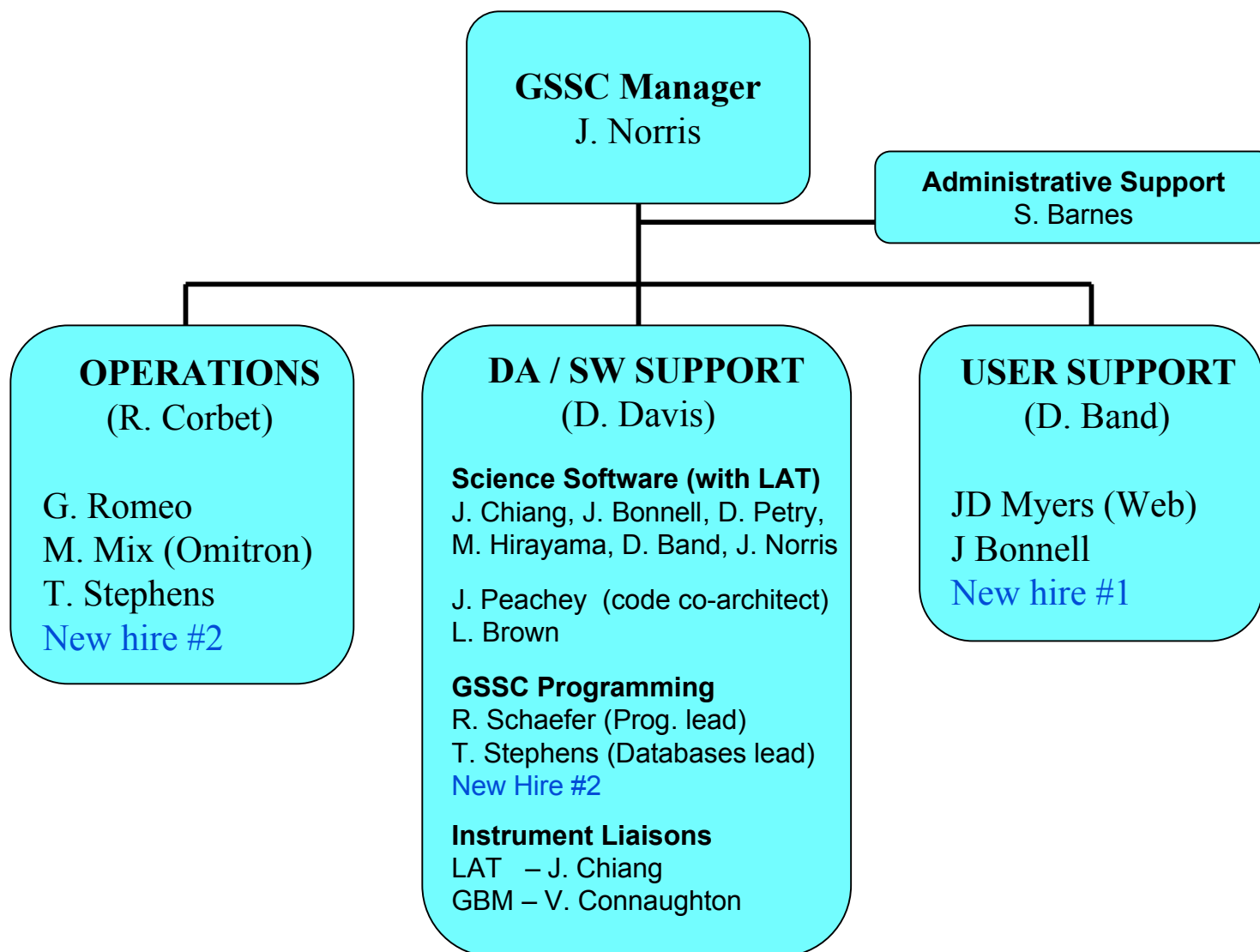


Ground System/Ops Organization





GSSC Organization





GSSC Role in the GLAST Project



- ▶ ***The GLAST Science Support Center, GLAST's interface with the scientific community:***
 - *Supports the Guest Investigator Program;*
 - *Disseminates data, analysis tools and documentation to the science community;*
 - *Maintains the science timeline;*
 - *Vets IOC commands for impact on timeline;*
 - *Upon Project Scientist's approval, sends ToO order to MOC;*
 - *Archives data in the High Energy Astrophysics Science Archive Research Center (HEASARC).*



Results from Peer Reviews

- ▶ ***Held 2 GSSC Peer Reviews***
 - *November 24, 2003*
 - *July 13, 2004*
- ▶ ***19 RFA's from the November 2003 peer review***
 - *15 GSSC RFAs closed*
 - *2 are ground system RFAs*
 - *1 withdrawn*
 - *1 GSSC RFA open. RFA requested revisions to GSSC Functional Requirements Document, and study of traces to this document; closure requires baselining revisions to documents*
- ▶ ***11 draft RFAs from the July 2004 Peer Review; official RFAs not yet submitted to GSSC***



RFA's From First Peer Review

#	Author	Topic	Status
1	Marshall, Schweiss	Independent future GSSC Reviews	Closed
2	Marshall	FTOOLs issues to resolve: multiplatform support, duplication of release	Closed
3	Marshall	Location of computers: BAP and GSSC operations	Closed
4	Marshall, Henegar	End-to-end data tracking system	Passed to ground system
5	Digel	DTS concerns of LAT team	Closed
6	Rioux	Review Security Guidelines	Passed to ground system
7	Marshall, Schweiss	Duplication of Level 0 archiving	Closed
8	Marshall, Rioux, Corcoran, Schweiss	Incomplete requirements on GSSC: SSC changing timeline, orphan requirements	Open
9	Paciesas, Shrader	Need formal software test plan and schedule, with independent test manager	Closed
10	Paciesas,	Need trade studies schedule, etc.	Closed
11	Paciesas	GSSC products need ITAR review	Closed
12	Shrader, Boyd, Digel	Archive interface HEASARC issues, which databases archived?	Closed
13	Boyd, Shrader	GI support issues: schedule is tied to delivery of software and calibration products, helpdesk response time, PIMMS for simulation	Closed
14	Corcoran	Data staging disk space concern	Closed
15	Corcoran, Marshall	Database concerns: Tracking photons by processing version, data staging disk space sufficient for many large queries?	Closed
16	Shrader, Boyd	Two stage review is unnecessary	Closed
17	Digel	Plan for proprietary data contingency	Closed
18	Rioux	Verification Reference Handbook	Withdrawn
19	Schweiss	Ops Information Missing: Concept Document, Staffing Requirements, Users Guide	Closed



Draft RFAs From Detailed Design Peer Review

Corcoran	<i>Clarify backup processing pipeline requirements.</i>
Corcoran	<i>Define calibration database plan in GSSC-HEASARC MOU.</i>
Drake	<i>Make HEASARC's contributions explicit in relevant diagrams.</i>
Shrader	<i>Give accurate estimates of data volumes, storage and processing requirements.</i>
Drake	<i>Give accurate estimates of data volumes.</i>
Digel	<i>GSSC should perform checks on instrument commanding.</i>
Paciesas	<i>Better define commanding process details.</i>
Drake	<i>(i) Clarify interaction between scheduling & planning tools, (ii) Give dates for Tako modifications.</i>
Digel	<i>Ensure scheduling requirements are complete.</i>
Digel	<i>Ensure RPS is sufficient for calibration observation requests.</i>
Paciesas	<i>Determine whether support for SAE under MS Windows is traceable to higher level requirement.</i>



GSSC – HEASARC Relationship

- ▶ *The **HEASARC** and the GSSC are constituents of the Office of Guest Investigator Programs (OGIP) within LHEA.*
- ▶ *Mutual requirements are stated in a GSSC-**HEASARC** MOU.*
- ▶ *Following standard **HEASARC** practice, the **HEASARC** pays for (and maintains) the GSSC's CPUs and the GSSC pays for the storage devices. The exception is the GSSC's Beowulf – required for the LAT photon database – which the GSSC will buy.*
- ▶ *The **HEASARC** maintains the software environment in which many missions' software is implemented.*
 - *GLAST is extending and using HEADAS for the analysis tools.*
 - *The GSSC is using **HEASARC** file conventions; the GSSC's data can be readily archived at the **HEASARC**.*
- ▶ *The **HEASARC** will maintain the GLAST data and software for posterity.*

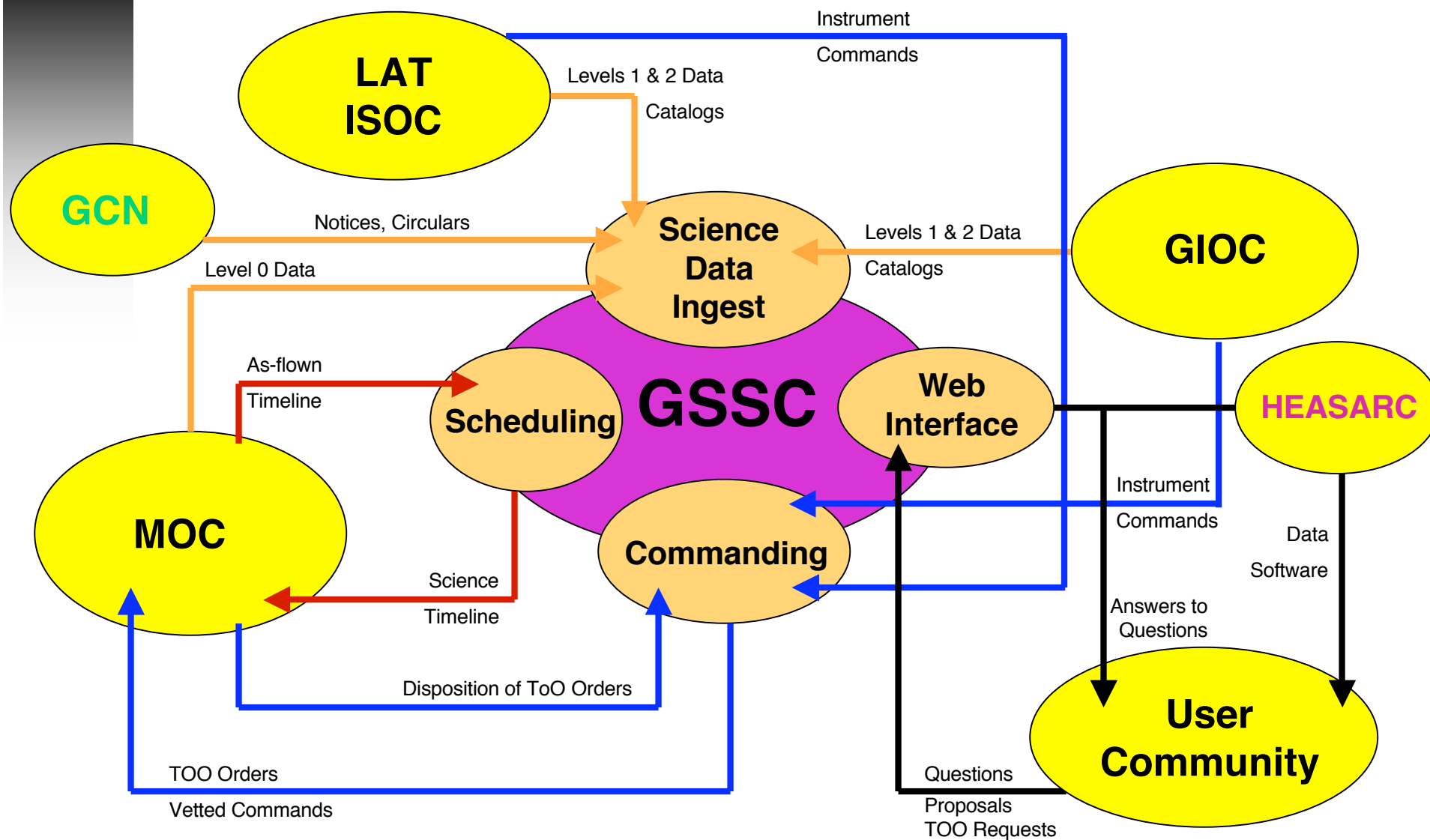


GRB Coordinates Network (GCN)

- **The *GCN* originates in LHEA at GSFC.**
 - *Procedures to submit or receive data posted at gcn.gsfc.nasa.gov.*
 - *The lead is Scott Barthelmy.*
- **The *GCN* distributes Notices, providing burst locations to observers and robotic telescopes.**
 - *The Notices are submitted to *GCN* by socket connection.*
 - *These Notices go out by socket, e-mail, or pages.*
- **The *GCN* will distribute GLAST Notices from:**
 - *The BAP (provided by the GIOC)—burst alerts from the GBM or LAT (in Notices format), OR locations calculated by the BAP*
 - *The LISOC—from Level 1 data*
 - *The GIOC—from TDRSS-downlinked GBM data or from Level 1 data*
- **The *GCN* also distributes Circulars submitted by observers by e-mail. The GIOC and LISOC will write circulars based on their analysis of their Level 1 data.**

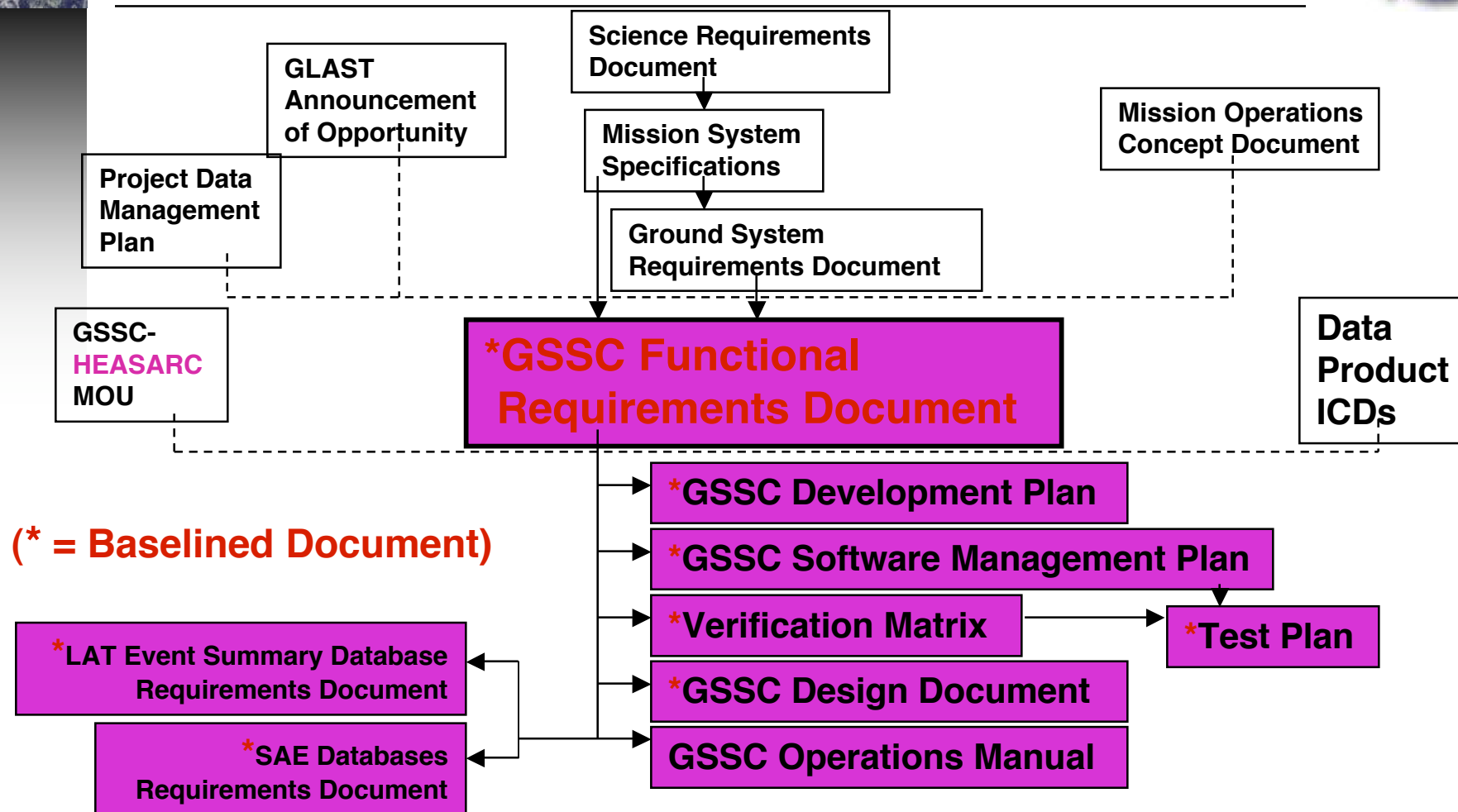


GSSC-Centric Communications/Data Flow





GSSC Document Tree



The baselined documents are found at:

http://glast.gsfc.nasa.gov/ssc/dev/baselined_documents/

and the current drafts at:

http://glast.gsfc.nasa.gov/ssc/dev/current_documents/



GSSC-Relevant Documents

<i>Document</i>	<i>Purpose</i>	<i>Draft</i>	<i>Final</i>	<i>CCB</i>
Project Data Management Plan	<i>Describes mission's flow of data; includes data policy statement. Maintained by User Support Manager. Reviewed; not signed.</i>	9/01	10/04	Project
GSSC Functional Requirements Document	<i>The GSSC's requirements. Written before Ground System Requirements Document; update has not yet been through CCB.</i>	9/01	10/04	Project
Science Data Products ICD	<i>Describes the science data products. Based on a 2 year-old working group report. The GSSC is the lead.</i>	10/03	10/04	Ground System
Operations Data Products ICD	<i>Describes the operations data products that will be exchanged among the MOC, IOCs and GSSC. The MOC is the lead.</i>	10/03	10/04	Ground System
GSSC-HEASARC MOU	<i>MOU establishing mutual GSSC and HEASARC requirements. GSSC is lead.</i>	9/02	7/04	Ground System
The Standard Analysis Environment for LAT Data	<i>Defines the tools and software environment for the scientific analysis of LAT data. Developed by GSSC-LAT Software Working Group.</i>	9/02	3/04 3/05 9/06	LAT team
LHEA IT Security Plan	<i>Establishes the IT security plan for LHEA</i>	NA	NA	LHEA



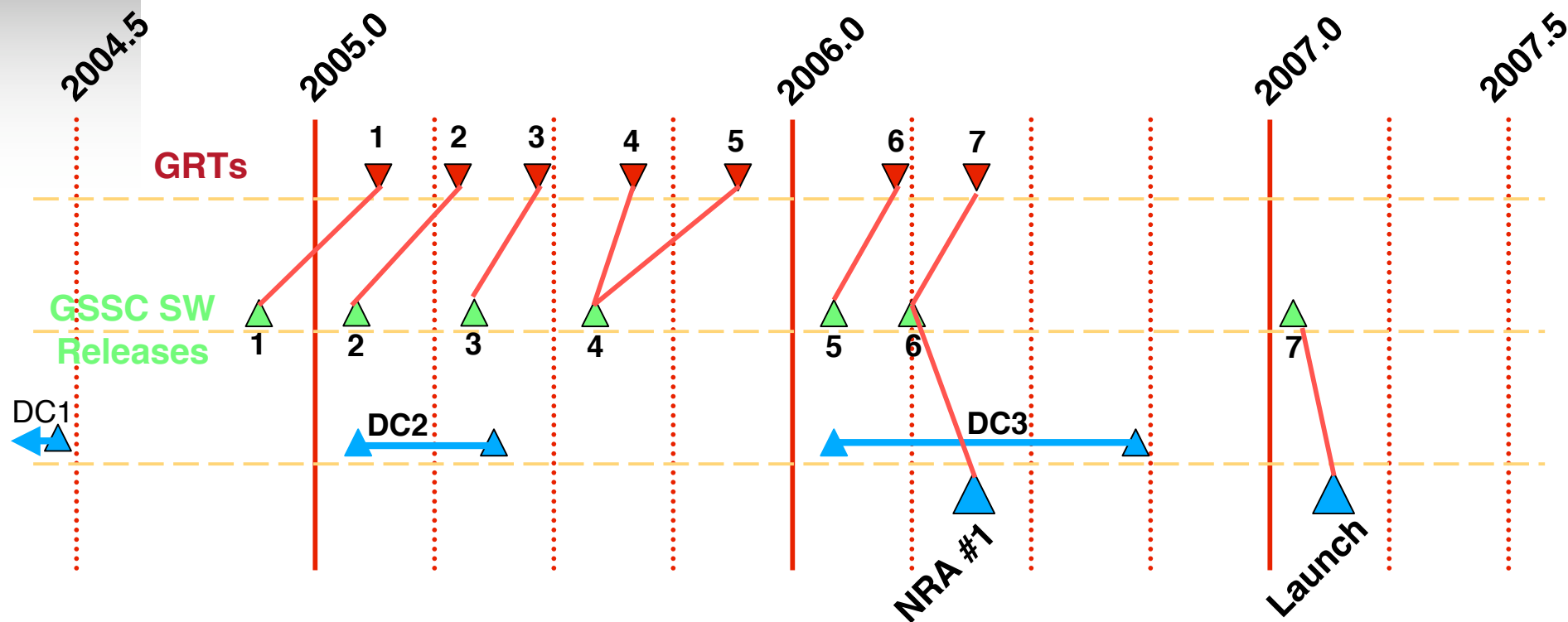
Internal GSSC Documents

<i>Document</i>	<i>Purpose</i>	<i>Status, Owner</i>
<i>GSSC Development Plan (GSSC-0001)</i>	<i>Plan for developing the GSSC and its software</i>	<i>Baselined 7/04, D. Band</i>
<i>GSSC Verification Matrix (GSSC-0002)</i>	<i>Matrix tracking GSSC compliance with its requirements</i>	<i>Baselined 7/04, D. Petry</i>
<i>GSSC Design Document (GSSC-0003)</i>	<i>Design of the GSSC and its systems. Includes descriptions of hardware and GSSC-specific software</i>	<i>Baselined 7/04, R. Schaefer</i>
<i>GSSC Software Management Plan (GSSC-0004)</i>	<i>Plan for developing and managing the GSSC's software</i>	<i>Baselined 7/04, R. Schaefer</i>
<i>GSSC Test Plan (GSSC-0005)</i>	<i>Plan for testing GSSC's functions, particularly software</i>	<i>Baselined 7/04, T. Stephens</i>
<i>GSSC Operations Manual</i>	<i>Plan for the GSSC's operation</i>	<i>To be developed for ORR</i>
<i>LAT Event Summary DB Req. Document (GSSC-0006)</i>	<i>Requirements for the database from which lists of LAT photons will be extracted</i>	<i>Baselined 7/04, R. Schaefer</i>
<i>Science Tools DBs Req. Document (GSSC-0007)</i>	<i>Requirements for all other databases associated with the Standard Analysis Environment</i>	<i>Baselined 7/04, R. Schaefer</i>
<i>Informal documents on GSSC internal website: memos, white papers, etc.</i>		

► **These documents are under internal CM.**



GSSC SW Releases in GLAST Timeline





GSSC Software Releases

- ▶ **Release 1 (11/15/04) [GRT 1 (02/15/05)]**
 - *Level 0 HSKP file transfers from MOC*
- ▶ **Release 2 (02/01/05) [GRT 2 (04/15/05)]**
 - *Commands from IOCs, Timelines to MOC, Project DB from MOC*
- ▶ **Release 3 (05/01/05) [GRT 3 (06/15/05)]**
 - *BAP Operations, Scheduling Tool, Ingest of integrated scheduling*
- ▶ **Release 4 (08/01/05) [GRT 4 (09/01/05) & 5 (11/15/05)]**
 - *Operations Planning Tools, Ingest Tools for Levels 1–3 data*
- ▶ **Release 5 (01/31/06) [GRT 6 (03/15/06)]**
 - *Backup Level 1 pipelines, TOO Tools, GI Support Tools*
- ▶ **Release 6 (04/03/06) [GRT 7 (05/15/06); NRA 1]**
 - *Ingest Tools for Notifications, SAA Updates, Pulsar Ephemerides; GI NRA Support Tools*
- ▶ **Release 7 (01/15/07) [Pre-Launch Check]**
 - *Cleanup; Website complete*



GSSC Operations

Robin Corbet
corbet@milkyway.gsfc.nasa.gov



GSSC Role in Operations

- ▶ ***Generate science timeline.***
- ▶ ***Monitor as-flown timeline.***
- ▶ ***Ingest commands sent from Instrument Operations Centers, evaluate any impact on science timeline, pass on to MOC.***
- ▶ ***Respond to Target of Opportunity (ToO) requests from within or outside GLAST team.***
- ▶ ***Transfer of Level 0 data and similar is not considered part of operations.***



Post-Launch Operations Staffing



► ***GSSC post-launch operations will require:***

- ***Timeline Scheduler—0.25 and 1.0 FTE at BS/MS level, depending on number and complexity of pointed observations***
 - *Run scheduling and planning software*
 - *Monitor as flown timeline*
 - *Respond to and evaluate TOO requests*
 - *Respond to and evaluate timeline impacts of IOC commands passed through GSSC*
- ***On-call GSSC Duty Scientist—role rotated weekly among the GSSC scientists***
 - *Monitor as flown timeline*
 - *Respond to and evaluate TOO requests*
 - *Respond to and evaluate timeline impacts of IOC commands passed through GSSC*



GSSC Functional Requirements – Operations (1/2)

Top Driving Requirements	
Requirement	Description
<i>FRD 5.4.1.4</i>	<i>Delivery of Weekly Science Timelines</i>
<i>FRD 5.4.1.5.3</i>	<i>Generation of ToO orders</i>
<i>FRD 5.4.1.6.1</i>	<i>Receipt and Transmission of Instrument Commands</i>

Regular Observations	
<i>FRD 5.3.2.9</i>	<i>Scheduling Guest Investigations</i>
<i>FRD 5.4.1.1</i>	<i>Timeline Tools</i>
<i>FRD 5.4.1.2</i>	<i>Planning the Science Timeline</i>
<i>FRD 5.4.1.3</i>	<i>Posting the Timeline</i>
<i>FRD 5.4.1.4</i>	<i>Weekly Science Timeline, Interface with MOC, ISOC, & GIOC</i>
<i>FRD 5.4.1.4.4</i>	<i>Observational Constraints (Earth avoidance etc.)</i>
<i>FRD 5.4.1.4.5</i>	<i>Revision of Science Timeline in response to TOO/ARs</i>
<i>FRD 5.4.1.4.6,7,8</i>	<i>Receipt of Observatory & As-flown Timelines, Orbit products</i>



GSSC Functional Requirements – Operations (2/2)

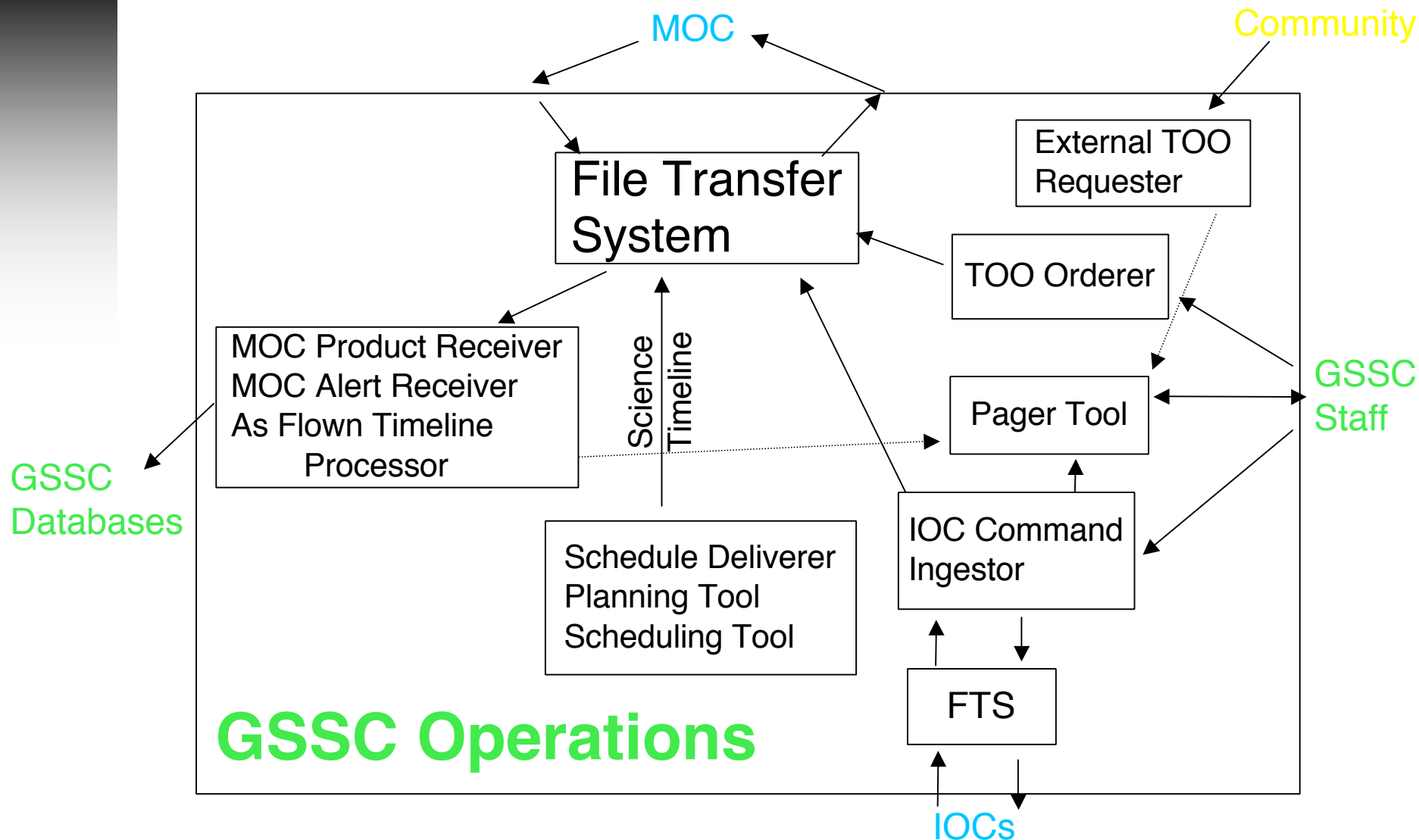


TOO Requests	
Requirement	Description
<i>FRD 5.4.1.5.1</i>	<i>Receive TOO Requests</i>
<i>FRD 5.4.1.5.2</i>	<i>Support Project Scientist TOO Decision</i>
<i>FRD 5.4.1.5.3</i>	<i>Generate TOO Orders</i>
<i>FRD 5.4.1.5.4</i>	<i>Receipt of TOO Status</i>
<i>FRD 5.4.1.5.5</i>	<i>TOO Log</i>
<i>FRD 5.4.1.5.6</i>	<i>Receipt of TOO Execution Notification</i>
<i>FRD 5.4.1.5.7</i>	<i>Notify TOO Requester</i>

Command Flow	
<i>FRD 5.4.1.6.1</i>	<i>Receive commands from IOCs and transfer to MOC</i>
<i>FRD 5.4.1.6.2</i>	<i>Immediate Transmission of High Priority Commands</i>
<i>FRD 5.4.1.6.3</i>	<i>Schedule Normal Priority Commands</i>
<i>FRD 5.4.1.6.4</i>	<i>Maintain Integrity of LAT and GBM Commands</i>
<i>FRD 5.4.1.6.5</i>	<i>Command Logging</i>
<i>FRD 5.4.1.6.6</i>	<i>Autonomous Data Transfers to/from MOC</i>
<i>FRD 5.4.1.6.7</i>	<i>Support Automated MOC</i>



GSSC Operations Overview – Internal Workings





Overview of Basic Scheduling and Planning

- ▶ ***GSSC creates long term schedule (LTS) covering ~ 1 year with one week resolution. The LTS is based on:***
 - *Sky survey requirements*
 - *Proposed observations*
- ▶ ***From the LTS the GSSC creates detailed Science Timelines covering week-long periods.***
- ▶ ***Science Timelines specify:***
 - *Survey observations*
 - *Pointed observations*
 - *Pointings to allow high rate TDRSS data dumps are possible but probably not needed.*
- ▶ ***Due to long TDRSS scheduling lead time, preliminary science timeline is delivered to MOC ~ 1 month before implementation, but timeline can be updated a few days beforehand.***



More Complicated Scheduling and Planning

- ▶ ***Planned GLAST Science Timeline can be disturbed by:***
 - *Auto-repoints caused by gamma-ray bursts.*
 - *Target of Opportunity observations.*
 - *Instrument or spacecraft anomalies.*
- ▶ ***After receipt of as-flown timeline GSSC automatically evaluates impact on scheduled observations (Op 10).***
- ▶ ***Future schedules may be modified to account for effects on survey and pointed observations.***
- ▶ ***Long term schedule and future Science Timelines adjusted as needed.***



Science Timeline Generation Details



- ▶ **Planning Tool (Op 90)** *investigates observing modes*
 - *Davis/Stoneking orbit simulator.*
- ▶ **Scheduling Tool (Op 100—Tako)** *produces science timelines*
 - *Annual schedule with 1 week resolution for internal use*
 - *Weekly science timeline transmitted to MOC and made available to the world via the web.*
 - *Tako: written for Astro E, modified for Swift, used by RXTE, will be used by Astro E2.*
 - *Trade study compared Tako and STK Scheduler based on list of requirements and desired capabilities. Tako chosen.*
 - *Accounts for SAA passages, Earth occultation of target, slew occurrences and durations*
- ▶ **Sky Coverage Monitor (Op170 followed by S-02)** *monitors the spatial and temporal exposure resulting from timelines*



Target of Opportunity Observations

- ▶ *TOO requests may come from within or outside GLAST team.*
- ▶ *Interface for TOO requests is web form. Based on RXTE experience and incorporates RPS.*
- ▶ *GSSC staff and project scientist alerted by pages/email (Op 140) when TOO request made.*
- ▶ *GSSC examines feasibility etc. (Op 150) of TOO request and provides advice to Project Scientist.*
- ▶ *Project Scientist (or designate) determines if TOO is to be done.*
- ▶ *Once the Project Scientist approves the TOO, the GSSC communicates the TOO order to the MOC within 2 hours.*
- ▶ *If TOO can be accommodated in regular timeline generation, done that way.*
- ▶ *If TOO decided, TOO Orderer tool (Op 120) sends order to MOC, alerts GSSC staff and TOO requester, and archives request.*



Instrument Command Processing

- ▶ *Instrument commands originate at ISOC and GIOC and are transferred to GSSC via “FTS” system.*
- ▶ *Commands must have companion “message files” (previously called “wrappers”) to specify:*
 - *description of contents of file and effect on instrument.*
 - *urgency of command transmission to MOC.*
- ▶ *FITS and XML were considered as formats for “message files” and FITS chosen (both formats meet needs).*
- ▶ *Initial keyword list now generated.*
- ▶ *Command Ingestor (Op 70) in GSSC logs commands.*
 - *For standard priority commands, waits for GSSC staff to approve, and approve or assign any desired time for execution before transmission to MOC.*
 - *High priority instrument commands transmitted to MOC immediately, relevant GSSC staff alerted (email, pages, text messages). This is for contingency operations only.*



Alert System/Pager Tool (Op 140)



- ▶ *Some inputs such as high priority commands from IOCs and TOO requests may require urgent notification of GSSC staff.*
- ▶ *Will use method based on sophisticated RXTE system.*
- ▶ *Combination of commercial (TelAlert) plus home-grown system. Alerts appropriate staff by paging, text messages to cell phones, email.*
- ▶ *Has “escalation” system plus methods for putting messages on hold etc.*
- ▶ *Is more than enough to cope with more limited operations role of GSSC!*



GSSC Operations Software (1/2)



<i>Tool</i>	<i>Purpose</i>	<i>Origin</i>
<i>Op 10. As-Flown Timeline Ingest</i>	<i>Ingests as-flown timeline from the MOC and compares with science-timeline</i>	<i>Custom software + file transfer software (FTS)</i>
<i>Op 20. Integrated Obs. Timeline Ingest</i>	<i>Ingests integrated observatory timeline from the MOC and archives it.</i>	<i>Custom software + FTS</i>
<i>Op 30. Anomaly Reports Ingest</i>	<i>Ingests MOC anomaly reports and archives them.</i>	<i>Custom software + FTS</i>
<i>Op 40. GLAST Ephemeris Ingest</i>	<i>Ingests GLAST ephemeris from MOC and makes available to scheduling tool.</i>	<i>Custom software + FTS</i>
<i>Op 45. TDRSS Ephemeris Ingest</i>	<i>Ingests TDRSS from the MOC and makes available to the scheduling tool.</i>	<i>Custom software + FTS</i>
<i>Op 50. TDRSS Contact Schedule Ingest</i>	<i>Ingests TDRSS contact schedule from MOC, makes available to scheduling tool.</i>	<i>Custom software + FTS</i>
<i>Op 60. Obs. Telemetry & Command Database Ingest</i>	<i>Ingests from the MOC T&C databases and archives it.</i>	<i>Custom software + FTS</i>
<i>Op 70. Command Ingest</i>	<i>Ingests commands and memory loads from ISOC and GIOC</i>	<i>Custom software + FTS</i>
<i>Op 80. Command Submit</i>	<i>Submits commands to the MOC.</i>	<i>Custom software + FTS</i>



GSSC Operations Software (2/2)



<i>Tool</i>	<i>Purpose</i>	<i>Origin</i>
<i>Op 90. Planning Tool</i>	<i>Assists with the design of observing strategies.</i>	<i>Stoneking/Davis simulator+modifications</i>
<i>Op 100. Scheduling Tool</i>	<i>Generates the science timelines.</i>	<i>Tako</i>
<i>Op 110. Science Timeline Submit</i>	<i>Submits science timelines to the MOC.</i>	<i>Custom scripts + FTS</i>
<i>Op 120. TOO Orderer</i>	<i>Creates and submits TOO orders to the MOC.</i>	<i>Custom software + FTS</i>
<i>Op 140. Pager Tool</i>	<i>Alerts GSSC if urgent action is required (e.g. TOO request)</i>	<i>Reuse of RXTE system.</i>
<i>Op 150. TOO Evaluator</i>	<i>Assists Duty Scientist in evaluating feasibility of requested TOO observation.</i>	<i>SOT (suitability of target) from RXTE.</i>
<i>Op 160. Proposal Ingestor</i>	<i>Interface between Proposal Submission tools and Scheduling tool.</i>	<i>Custom software.</i>
<i>Op 170. ST2FT2 Reformat</i>	<i>Converts Science Timeline to FT2 format for use in sky coverage monitor.</i>	<i>Custom software.</i>



Development/Release Schedule Details (1/2)

- ▶ **Release 1 (11/15/04) – ingest of Level 0 data from MOC:**
 - *Scripts to move data from MOC to GSSC. Creation of GSSC database. Scripts to ingest data into GSSC database.*
- ▶ **Release 2 (2/01/05) – Preliminary command and schedule tools:**
 - *Command passing from IOCs to GSSC, and from GSSC to MOC. Timeline creation and passing to MOC.*
 - *Op 40. GLAST Ephemeris Ingest*
 - *Op 45. TDRSS Ephemeris Ingest*
 - *Op 60. Observatory T&C Ingest*
 - *Op 70. Command Ingest*
 - *Op 100. Preview of Scheduling Tool*
 - *Op 110. Science Timeline Submit*
- ▶ **Release 3 (5/1/05) – Ingest of Level 1 data from IOCs:**
 - *Scripts to move data from IOCs to GSSC. Creation of GSSC databases. Software to ingest data into GSSC databases.*
 - *Op 20. Observatory Timeline Ingest*
 - *Op 50. TDRSS Contact Ingest*



Development/Release Schedule Details (2/2)

- ▶ **Release 4 (8/1/05) – Scheduling tools:**
 - **Completion of command and schedule tools**
 - Op 10. As-Flown Timeline Ingest
 - Op 90. Planning Tool.
 - Op 100. Full-capability Scheduling Tool.
 - Op 160. Proposal Ingest.
 - Op 170. Science Timeline to FT2 converter

Release 5 (1/31/06) – Target of Opportunity and alert tools:

- Op 120. TOO Orderer
 - Op 140. Pager Tool
 - Op 150. TOO Evaluator
- ▶ **Release 6 (4/3/06) – (Ingest Tools; All Ops specific tools exist)**



Operations Software Development



► **Operations Section Staff:**

– **Robin Corbet**

- *GSSC Operations Lead*

– **Marilyn Mix**

- *50% GSSC, 50% MOC*
- *Tako development and MOC interfaces*

– **Giuseppe Romeo**

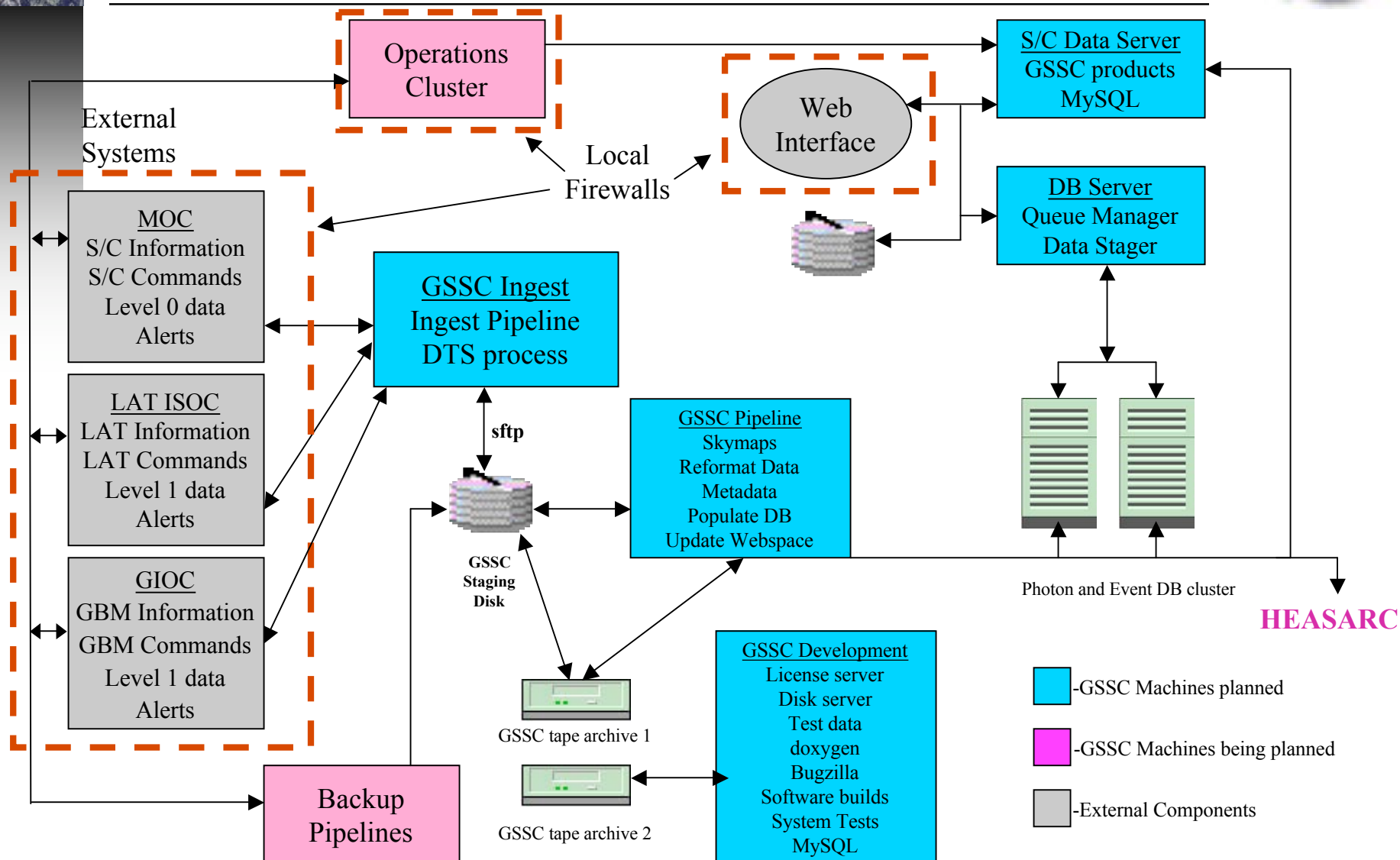
- *Utilities, Tako, leverage of RXTE experience*

– **Tom Stephens (also DA/SW Support Section)**

- *Data Ingest etc.*



GSSC Computer Architecture



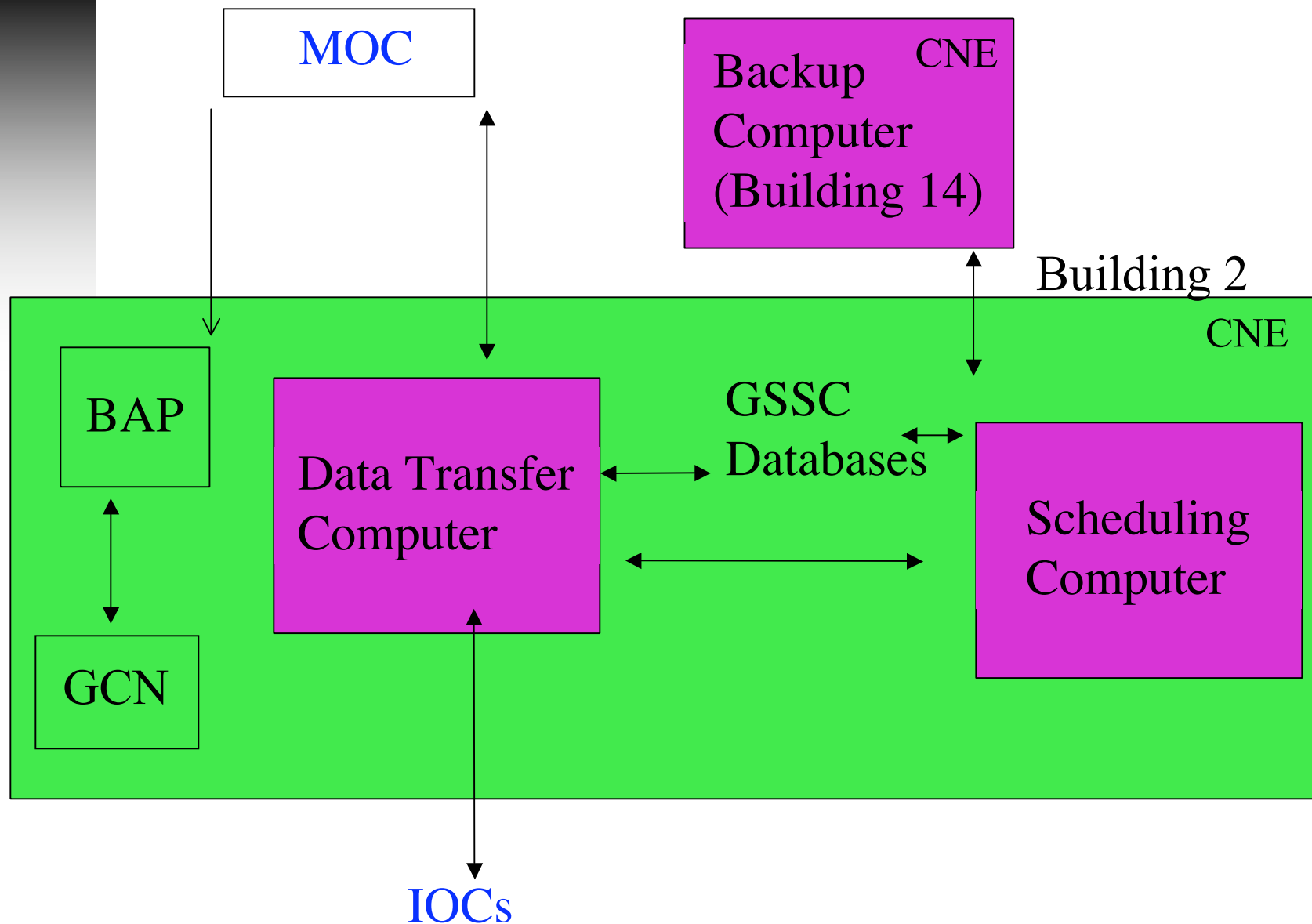


Computing

- ▶ ***Scheduling is largest computing demand. LINUX box easily handles “standard” observations (pointed and sky survey)***
 - *Tako designed to handle 400 targets/year for Astro-E.*
 - *In tests find Tako can schedule ~1300 targets in a one year schedule in less than 90 minutes (Apple Macintosh G4).*
- ▶ ***Nominal Operations computer configuration:***
 - *Scheduling machine in B2*
 - *Data transfer/ingestor/paging machine in B2*
 - *“Warm” backup machine in B14*
- ▶ ***Operations computers in B2 for accessibility, B14 backup on MOC UPS for reliability. Automated daily backups from B2 to B14 computers. “Process monitor” from RXTE automatically checks system status.***
- ▶ ***GSSC will maintain GIOG BAP machine in B2, with same reliability as GCN in B2.***



Operations Computer Hardware Overview





IT Security

- ▶ ***GSSC will follow accepted NASA procedures as defined in NASA Procedural Requirements (NPR) 2810.1. GSSC also covered by GLAST project security plan and LHEA security plan.***
- ▶ ***Building 2 (LHEA) computer network uses CNE network. CNE is used by mission operations systems for administrative information and science data transfer.***
- ▶ ***The GSSC machine in B14 will also be on CNE.***
- ▶ ***GSSC will utilize a firewall for protection from outside intrusion.***
- ▶ ***Timelines and command uploads will use PGP authentication. (Not encryption).***



GSSC Pipelines

Tom Stephens
tstephen@milkyway.gsfc.nasa.gov



General Ingest Requirements

General Requirements	
Requirement	Description
FRD 5.4.1.4.1	<i>The GSSC shall interface with the MOC for the exchange of mission planning products.</i>
FRD 5.4.1.4.2	<i>The GSSC shall interface with the ISOC for the exchange of mission planning products.</i>
FRD 5.4.1.4.3	<i>The GSSC shall interface with the GIOC for the exchange of mission planning products.</i>
FRD 5.7.1.2	<i>The GSSC shall receive and archive reports and analyses from the MOC.</i>
FRD 5.7.1.3	<i>The GSSC shall interface with the ISOC for the exchange of data products.</i>
FRD 5.7.1.4	<i>The GSSC shall interface with the GIOC for the exchange of data products.</i>
FRD 5.7.1.6	<i>The GSSC shall receive data products from the MOC, ISOC or GIOC as follows: ...</i>
FRD 5.7.1.7	<i>The GSSC shall maintain the integrity of science data received from the IOCs.</i>



Specific Data Product Requirements

Specific Data Product Requirements	
Requirement	Description
FRD 5.4.1.4.10	<i>The GSSC shall receive the TDRSS Contact Schedule Request from the MOC.</i>
FRD 5.4.1.4.11	<i>The GSSC shall receive the Confirmed TDRSS Contact Schedule Request from the MOC.</i>
FRD 5.4.1.4.12	<i>The GSSC shall receive the Integrated Observatory Timeline from the MOC.</i>
FRD 5.4.1.4.13	<i>The GSSC shall receive the orbit data products from the MOC.</i>
FRD 5.4.1.4.14	<i>The GSSC shall receive the as-flown timeline from the MOC.</i>
FRD 5.4.1.5.1	<i>The GSSC shall receive TOO requests from the science community</i>
FRD 5.4.1.5.4	<i>The GSSC shall receive from the MOC information that specifies the status of the TOO order.</i>
FRD 5.4.1.5.6	<i>The GSSC shall receive TOO execution notification from the MOC.</i>
FRD 5.4.1.6.1	<i>The GSSC shall receive Absolute Time Commands from the IOCs.</i>
FRD 5.4.1.6.2	<i>The GSSC shall receive Real Time Commands and File Loads from the IOCs.</i>
FRD 5.4.1.6.3	<i>The GSSC shall pass high priority commands, as identified by the IOCs, to the MOC immediately</i>
FRD 5.4.1.6.6	<i>The GSSC shall support autonomous data transfers to and from the MOC</i>
FRD 5.7.1.1	<i>The GSSC shall receive and archive Level 0 data from the MOC</i>
FRD 5.7.1.8	<i>The GSSC shall receive GLAST-produced GCN Notices and Circulars from the GCN.</i>
SAEDR 4.4.1.2	<i>Must be able to ingest spacecraft livetime history tables generated by the ISOC for roughly 5 hour periods delivered 5 times per day</i>
SAEDR 4.4.2.2	<i>Must be able to ingest the latest complete source catalog updated when necessary by the ISOC</i>
SAEDR 4.4.3.2	<i>Must be able to ingest new pulsar ephemerides on update. Must also be able to ingest tables with varying numbers of pulsar ephemerides.</i>



Throughput and Speed Requirements

Throughput and Speed Requirements	
Requirement	Description
FRD 5.7.1.5.1	<i>The GSSC shall be capable of receiving, processing, and archiving Level 0 and Level 1 data resulting from a single downlink of at least 36 hours of observatory data.</i>
FRD 5.7.1.5.2	<i>The GSSC shall be capable of receiving, processing and archiving the Level 0 and Level 1 data generated at an orbit-averaged rate of 1.2 Mbps for LAT, 12 kbps for GBM and 51 kbps for observatory housekeeping data.</i>
LESDR 5.2.3.3	<i>Data must be available for searching in the database 10 minutes after the start of the ingest process for a newly delivered photon summary file assuming the file contains no more than 5 hours worth of data.</i>
LESDR 5.2.3.4.2	<i>A reprocessed 5 hour time photon summary file must be able to be inserted into the database without undue interruption. (It must take less than 60 minutes to make the new version of the data available for that interval.)</i>
LESDR 5.2.4.3	<i>Data must be available for searching in the database 100 minutes after the start of the ingest process for a newly delivered event summary file assuming the file contains no more than 5 hours worth of data.</i>
LESDR 5.2.4.4.2	<i>Reprocessing an existing 5 hour time interval of data must be done without undue interruption (<10 hours)</i>
SAEDR 4.4.1.5.1	<i>Must be able to ingest a newly delivered 5 hour data table in < 1 minute</i>
SAEDR 4.4.1.5.3	<i>Must be able to input a reprocessed 5 hour data table in < 5 times the time it takes to ingest a brand new table.</i>
SAEDR 4.4.2.5.1	<i>10Mb of LAT point source data must be able to be ingested and read for searching in < 10 min</i>
SAEDR 4.4.2.5.3	<i>Must be able to update tables of refined point source entries at < 5 times the ingest rate</i>
SAEDR 4.4.3.5.1	<i>Must be able to ingest 1 Mb worth of pulsar ephemerides tables in < 1 min</i>
SAEDR 4.4.3.5.3	<i>Must be able to load an updated database in < 5 times the ingest speed</i>

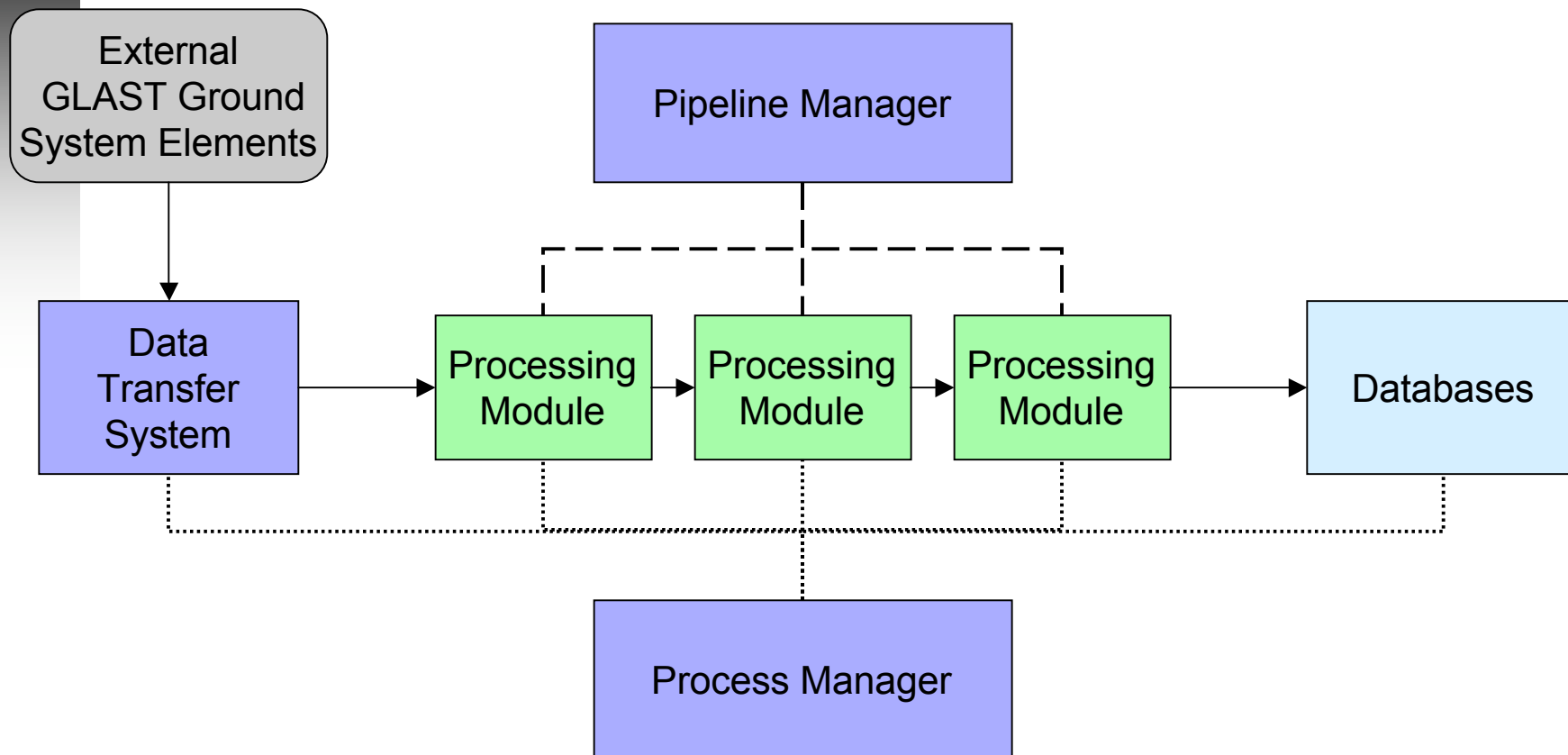


General Ingest System Features

- ▶ *Provides mechanism by which data is transferred to the GSSC and put into databases accessible by the community*
- ▶ *Automated, hands free system to provide rapid processing of data.*
- ▶ *Consists of four main components*
 - *Data Transfer System – physically moves the data from the elements of the Ground System to the GSSC*
 - *Process Manager – Monitors hardware and software components of the Ingest system. Corrects errors detected and notifies operator in case of serious failures or problems*
 - *Pipeline Manager – Controls the processing of data as it arrives*
 - *Data Processing Modules – Individual modules activated by the Pipeline Manager to process the data. Includes modules to extract metadata, populate databases, data integrity checks, etc. Customized to each specific data product processed.*



Ingest System Diagram



- Data Flow
- - - Execution Control
- Process Monitoring



Process Manager

- ▶ ***Provides automatic oversight of all processing modules and available resources such as disk space and CPUs.***
- ▶ ***Can take corrective action without operator intervention.***
- ▶ ***Notifies appropriate parties in the case of serious errors.***
- ▶ ***Maintains logs of the state of all processes and resources.***
- ▶ ***GSSC will use the Process Manager developed for RXTE with modifications to handle the GSSC's computer system.***
 - ***Back end is a series of scripts that monitor and log system state***
 - ***Front end is a GUI that allows operator to examine and control the state of the system***



Pipeline Manager – OPUS

- ▶ *We use OPUS “out of the box!” Fits GSSC needs: OPUS controls data processing per arrival, insures proper handling.*
- ▶ *Developed at STScI for processing of HST data.*
- ▶ *Lightweight & Flexible*
 - *OPUS only provides pipeline management backbone*
 - *Actual processing steps can be arbitrarily simple or complex*
- ▶ *Scalable*
 - *OPUS is designed to manage multiple instances of multiple processing steps on multiple computers.*
 - *Additional processing resources can be added “on the fly”.*
- ▶ *Pre-built monitoring GUI’s*
 - *Process Manager (PMG) – View of processes associated with each branch of the pipeline including number of instances, location of processes and data currently being processed.*
 - *Observation Manager (OMG) – Data oriented view showing which stages of the pipeline have been complete for each data set.*
 - *Written in Java and can be run from anywhere.*



Data Tracking & Error Handling

► **Data Tracking and Accountability**

- *Each step of processing is logged in a MySQL database.*
- *Database tables log start and completion time for each stage of the processing pipeline for each file that moves through the system.*
- *Important metadata are also tracked, including data contents, revision numbers, etc.*

► **Error Handling**

- *When there is an error, OPUS flags the data set that had the error and the processing step in which the error occurred.*
- *Additional portions of the pipeline system monitor all data for error conditions.*
- *Appropriate actions taken based on error type. Some examples are:*
 - *“Known” processing error*
 - *Unexpected processing error*
 - *Crashed process*
- *All errors are logged.*



Data Ingest Completion Milestones

- ▶ ***OPUS is already installed and running***
- ▶ ***Initial Ingest branch designed and prototype has been implemented***
- ▶ ***Data specific module completion tied to GSSC Software Releases***
 - ***Release 1 (11/15/04) – Data Transfer System, OPUS, Initial Ingest branch and Level 0 specific Pipeline***
 - ***Release 2 (02/01/05) – Operations Data I***
 - ***Release 3 (05/01/05) – Operations Data II***
 - ***Release 4 (08/01/05) – GBM Science Data, LAT Science Data, Operations Data III***
 - ***Release 5 (01/31/06) – Anomaly Reports pipeline and Process Manager***
 - ***Release 6 (04/03/06) – All remaining data***
 - ***Release 7 (01/15/07) – No new modules***



GSSC Pipelines: Summary

- ▶ *Ingest pipeline handles all data coming into the GSSC*
- ▶ *Process Manager will use the RXTE system*
- ▶ *OPUS will serve as the Pipeline Manager for the GSSC*
- ▶ *OPUS and initial ingest pipeline prototype installed and running*
- ▶ *All data will be tracked in an Ingest database*
- ▶ *Series of specific milestones for system completion*



GSSC Data Archive and Software

Dave Davis

ddavis@milkyway.gsfc.nasa.gov



Outline

- ▶ ***Requirements***
- ▶ ***Serving the community***
- ▶ ***Data and database requirements***
- ▶ ***GSSC databases and security***
- ▶ ***Software - definition and change process.***
- ▶ ***Databases***



Community Connection

- ▶ ***A major GSSC role is providing the scientific community with data and the tools to analyze GLAST data. This entails:***
 - *Data ingest into the GSSC (with software)*
 - *Data storage at the GSSC (with databases)*
 - *Serving data to the community through GSSC website*
 - *Providing the user community with analysis tools*
 - *Providing the user community with analysis guides*
- ▶ ***The GSSC data archive supports the GLAST GI via***
 - *Providing calibration data for proposal tools*
 - *Supporting the GI program with proposal databases (including ToO requests)*
- ▶ ***We support multi-wavelength observations by***
 - *Publishing the science timeline*
- ▶ ***Some of these roles are discussed in User Support Section.***



GSSC Database Requirements

GSSC Databases	
Requirement	Description
FRD 5.7.1	Receive data from the MOC and IOC's. <i>Level 0 data from the MOC</i> <i>Processed data from the IOC's (level 1 & 2)</i> <i>Reports and Analyses from the MOC</i> <i>GLAST related GCN notices</i>
FRD 5.7.2	Maintain databases for all the data products we receive from the MOC or IOC's
FRD 5.7.3	These databases will be physically connected to the HEASARC computer system
FRD 5.7.4	Most databases will be accessed though the web in accordance with the Mission data policies: <i>Processed data from the IOC's and GSSC</i> <i>Observation timelines</i> <i>ToO requests</i> <i>Instrument commands will NOT be publicly available</i>



HEASARC Compatibility & Security Requirements

<i>HEASARC Compatibility</i>	
<i>Requirement</i>	<i>Description</i>
FRD 5.7.5	<i>All databases will be turned over to HEASARC at mission end, and must be in a HEASARC-compatible form by then.</i>
FRD 5.7.6	<i>All software must be turned over to HEASARC at mission end.</i>

<i>Security</i>	
<i>Requirement</i>	<i>Description</i>
FRD 5.2.2	<i>The GSSC shall comply with NPR 2810.1</i>



Software



- ▶ ***Two types of software developed at GSSC***
 - ***GSSC Internal Software***
 - *Data Archive and Support Software - Pipelines and Databases*
 - *User Interface - GI proposal and web interface tools*
 - *Operations - Planning and Scheduling Tools*
 - *General infrastructure software*
 - ***GLAST Analysis Tools to analyze GLAST data***
 - *Strong participation in creation of LAT's Standard Analysis Environment*



GSSC Databases

- ▶ ***GSSC will maintain the databases listed in the GSSC Design Document***
- ▶ ***Three types of databases that all satisfy all relevant FRD 5.7.x***
 1. ***Database containing metadata which points to information in files (e.g. HEASARC Browse and CalDB Databases - which come with a web accessible interface)***
 2. ***Self contained databases (e.g. all data stored and searchable in MySQL database)***
 3. ***Customized data systems (used by GSSC for event and spacecraft pointing data). These will use HEASARC compatible file formats.***
- ▶ ***Type 1 in common usage in HEASARC - GSSC plans to use Browse and CALDB directly***
- ▶ ***Type 2 can be flat files or a DBMS system such as MySQL***
- ▶ ***Type 3 designed with performance, simplicity, and reliability as the highest priority design criteria.***



GSSC System Security

- ▶ ***System Access will be controlled***
 - *A firewall exists between the web site and all GSSC computers*
 - *Password authentication*
 - *Resource monitoring*
- ▶ ***Archive software will prevent common security “holes” with signal, error, and exception handling.***
- ▶ ***A secure file transfer system will be used for all file transfers.***
- ▶ ***Data Integrity***
 - *Utilize a well tested/free DBMS*
 - *Read-only archive for public access*
 - *Frequent backups*
 - *DB agents to check data integrity*



GSSC Databases



<i>Operations Databases</i>	
<i>Number</i>	<i>Origin</i>
8	MOC
4	ISOC
4	GIOC
1	GSSC

<i>GBM Databases</i>	
<i>Number</i>	<i>Origin</i>
15	GIOC

<i>LAT Databases</i>	
<i>Number</i>	<i>Origin</i>
10	ISOC

<i>Science Databases</i>	
<i>Number</i>	<i>Origin</i>
2	GSSC

<i>Internal Operations</i>	
<i>Number</i>	<i>Origin</i>
5	GSSC

<i>User Support DBs</i>	
<i>Number</i>	<i>Origin</i>
2	GCN
1	MOC



Archiving

- ▶ *All databases will be backed up and archived*
- ▶ *Copies will be kept on hard media*
- ▶ *An archive database will track properties of archival data:*
 - *Files archived*
 - *File sizes*
 - *Checksums*
 - *All Processing version numbers*
 - *Dates*
 - *Received by GSSC*
 - *Processed by GSSC*
 - *Archived*
 - *Physical medium where file is located*
 - *Minimum expected medium life*



Software Definition

- ▶ ***GSSC software tool functionality and interfaces based on***
 - *Requirements*
 - *Good practices of other HEA missions*
- ▶ ***Tool list vetted by GSSC members and documented in GSSC Design document.***
- ▶ ***Already existing software with required functionality identified, e.g.,***
 - *Lab software (Tako for scheduling)*
 - *Software from other missions (e.g. RXTE science operations center software)*
- ▶ ***Detailed functionality captured in internal tool requirements documents (determines size of development task).***



GSSC Software Release

- ▶ *Releases occur 6-12 weeks before GRTs for informal testing with other ground elements and fault correction*
- ▶ *Releases are preceded by 6-8 week code freezes during which
 - *GSSC system tests are carried out (see Test Plan)*
 - *Only bugs which prevent software from meeting its requirements are fixed**
- ▶ *Code which passes the system tests given official release tag in our code repository (CVS - Concurrent Versions System).*
- ▶ *Pre-release software is changed with section manager approval*
- ▶ *Software is officially released by the Configuration Control Board (CCB) consisting of: 3 section managers, software manager, GSSC manager, and other cognizant scientists and programmers.*
- ▶ *Post release software is changed with the approval of the CCB. All bugs and functionality change proposals are entered in the issue tracking system (Roundup)*



Summary



- ▶ ***We have reviewed the requirements for GSSC Databases & Security.***
- ▶ ***GSSC database and security implementation***
- ▶ ***Databases available from the GSSC***
- ▶ ***Software development processes***



***three (3) database
backup slides follow***



GSSC Operations Databases

Data Product	Science Data ICD id	Origin	GSSC Database ID	SAE ID	Release
1000 Planning and Scheduling Operations databases					
Level 0 Data		MOC	1510		GSSC 1
As-flown Timeline		MOC	1710		GSSC 4
GLAST Ephemeris		MOC	1730		GSSC 3
TDRSS Ephemerides		MOC	1731		GSSC 3
TDRSS Forecast Schedule		MOC	1740		GSSC 3
Requested TDRSS Contacts		MOC	1741		GSSC 3
Accepted GI Proposals		GSSC	1760		TBD
Notifications, Acknowledgements, Dispositions		MOC	1770		GSSC 3
LAT Instrument Commands		ISOC	1810		GSSC 2
LAT Instrument Memory Loads		ISOC	1811		GSSC 2
LAT Flight Software Loads		ISOC	1812		GSSC 2
LAT SAA Updates		ISOC	1820		GSSC 2
GBM Instrument Commands		GIOC	1850		GSSC 2
GBM Instrument Memory Loads		GIOC	1851		GSSC 2
GBM Flight Software Loads		GIOC	1852		GSSC 2
GBM SAA Updates		GIOC	1860		GSSC 2
Integrated Observatory Timeline		MOC	1890		GSSC 3



GSSC User Support and GBM Databases



Data Product	Science Data ICD id	Origin	GSSC Database ID	SAE ID	Release
2000 User and GI Support databases					
GCN Notices	SS-004	GCN	2710		TBD
GCN Circulars	SS-005	GCN	2711		TBD
Anomaly Reports		MOC	2720		GSSC 5
3000 Science Data GBM databases					
GBM CTIME (Daily Version)	GS-001	GIOC	3110		GSSC 4
GBM CTIME (Burst Version)	GS-102	GIOC	3111		GSSC 4
GBM TTE	GS-101	GIOC	3120		GSSC 4
GBM TRIGDAT	GS-107	GIOC	3130		GSSC 4
GBM Background Files	GS-105	GIOC	3140		GSSC 4
GBM CSPEC (Daily Version)	GS-002	GIOC	3210		GSSC 4
GBM CSPEC (Burst Version)	GS-103	GIOC	3211		GSSC 4
GBM Calibration	GS-006	GIOC	3410		GSSC 4
GBM DRMs	GS-104	GIOC	3411		GSSC 4
GBM Gain and Energy Resolution	GS-005c	GIOC	3420		GSSC 4
GBM Housekeeping (CHK)	GS-005a	GIOC	3510		GSSC 4
GBM Diagnostic Messages (Telemetry)	GS-005b	GIOC	3520		GSSC 4
GBM Burst Catalog	GS-009, GS-106	GIOC	3610		GSSC 4
GBM Trigger Catalog	GS-007	GIOC	3620		GSSC 4
GBM Burst Spectra Catalog	GS-008	GIOC	3630		GSSC 4



LAT and GSSC Databases

Data Product	Science Data ICD id	Origin	GSSC Database ID	SAE ID	Release
4000 Science Data LAT databases					
LAT Events	LS-002	ISOC	4110	D1ev	GSSC 4
LAT Transient Data	LS-007	ISOC	4112	D9	GSSC 4
Pointing & Livetime History	LS-005	ISOC	4120	D2	GSSC 4
Interstellar Emission Model	LS-010	ISOC	4140	D7	GSSC 4
LAT IRFs	LS-004	ISOC	4410	D3	GSSC 4
LAT Low-Level Calibration	LS-003	ISOC	4420		TBD
LAT Configuration History	LS-006	ISOC	4430		GSSC 4?
LAT Burst Catalog	LS-009	ISOC	4610	D6	GSSC 4
LAT Transient Catalog	LS-007	ISOC	4611	D6	GSSC 4
LAT Point Source Catalog	LS-008	ISOC	4620	D5	GSSC 4
5000 Science Data GSSC derived databases					
Photon Summary Data	SS-002	GSSC	5111	D1ph	GSSC 4
Pulsar Ephemerides	SS-001	GSSC	5630	D4	GSSC 4
6000 GSSC internal operations databases					
Data Product Tracking Database		GSSC	6710		GSSC 1
Data Processing		GSSC	6720		GSSC 4
Data Processing Anomalies		GSSC	6721		GSSC 4
Issue Tracking		GSSC	6730		GSSC 1
Re-Transmission Requests		GSSC	6740		GSSC 1

Note: Orange denotes DB's that are prototyped



GSSC User Support

David Band
dband@lheapop.gsfc.nasa.gov



Overview

- ▶ ***The User Support section assists the scientific community:***
 - *Analyze GLAST data*
 - *Prepare Guest Investigator (GI) Proposals*

- ▶ ***This section also runs the GI Program for NASA HQ:***
 - *NASA Research Announcement (NRA) development*
 - *GI Proposal administration*
 - *Technical evaluation of proposals*



User Support Requirements (1/4)

<i>GSSC-FRD Requirement</i>	<i>Description</i>
5.2.3—Website Section 508 Compliance	<i>The GSSC website shall comply with federal Section 508 requirements using the HEASARC style guide.</i>
5.3—Supporting the Guest Investigator (GI) Program	<i>The GSSC shall organize and administer the GLAST GI program.</i>
5.3.1—Development of the NASA Research Announcements (NRAs)	<i>With the guidance of NASA HQ, the GSSC shall write the NRAs along with the relevant supporting documents (e.g., mission plan, descriptions of the instruments, sensitivity tables).</i>
5.3.2.1—Tools for Preparing Proposals	<i>The GSSC shall provide software, sensitivity tables and other tools to assist with the preparation of the proposals.</i>
5.3.2.1.1—Different Accuracy and Generality Levels	<i>The proposal preparation tools shall provide proposers with different levels of accuracy and generality in planning their proposals.</i>
5.3.2.1.2—Multimission Comparisons	<i>The proposal preparation tools shall permit comparisons of the fluxes in different gamma-ray detectors.</i>
5.3.2.1.3—Orbit Fidelity	<i>GLAST's orbit shall be modeled by the proposal preparation tools with varying fidelity.</i>
5.3.2.2—Library of Previous Results	<i>The GSSC shall provide a library of previous results from GLAST and earlier gamma-ray missions.</i>
5.3.2.3—Selection of Peer Review Panels	<i>The GSSC shall identify a pool of scientists from which NASA HQ will select the members of the peer review panels.</i>
5.3.2.4—Technical Evaluation of Proposals	<i>The GSSC shall evaluate the technical feasibility of proposals.</i>



User Support Requirements (2/4)



<i>GSSC-FRD Requirement</i>	<i>Description</i>
5.3.2.5—Implementation of Peer Review Policies	<i>The GSSC shall implement the policies promulgated by NASA HQ regarding the peer review process (e.g., regarding conflict-of-interest).</i>
5.3.2.6—Convening the Peer Review	<i>The GSSC shall convene the peer review panels and shall provide logistical support.</i>
5.3.2.7—Supporting NASA HQ in Selecting Guest Investigations	<i>As requested, the GSSC shall support NASA HQ in selecting the guest investigations and in determining the funding awarded to the selected investigations.</i>
5.3.2.8—Administering the Guest Investigation Grants	<i>The GSSC shall administer the guest investigation grants through the appropriate GSFC grants office.</i>
5.3.2.9—Posting the Selected Guest Investigations	<i>The GSSC shall post the list of selected guest investigations on its website.</i>
5.3.3.1—Providing GIs With Requested Data	<i>The GSSC shall make any requested data available to a GI within a day after the GSSC receives them.</i>
5.3.3.2—Providing GIs With Analysis Software	<i>The GSSC shall provide GIs with a comprehensive suite of analysis software and related documentation.</i>
5.3.3.3—Providing GIs with Assistance	<i>The GSSC shall assist investigators analyze their data.</i>
5.3.3.3.1—Helpdesk	<i>The GSSC shall respond to investigator's queries submitted electronically.</i>
5.3.3.3.2—Helpdesk Response Time	<i>The GSSC shall respond within 2 business days.</i>
5.3.3.3.3—Monitoring Helpdesk Response Time	<i>The helpdesk system shall monitor and report the response time.</i>



User Support Requirements (3/4)



GSSC-FRD Requirement	Description
5.3.3.3.4—Logging Helpdesk Queries	<i>The investigator queries and the GSSC responses will be logged.</i>
5.3.3.3.5—FAQ	<i>A 'Frequently-Asked-Questions' (FAQ) section of the web-based documentation shall be extracted from the helpdesk queries.</i>
5.4.1.3—Posting the Timeline	<i>The timeline as implemented (for past observations) and as planned (for future observations) shall be posted on the GSSC website.</i>
5.4.1.5.1—Receipt of TOO Requests	<i>The GSSC shall receive TOO requests from the science community.</i>
5.4.1.5.7—Notification to the TOO Requester	<i>The GSSC shall notify the TOO requester of the TOO execution results.</i>
5.4.2—Public Information	<i>The GSSC shall post on its public website information related to the GLAST mission and its results for the support of GLAST-related research and for public information.</i>
5.4.3—Notifying the Investigator Community	<i>The GSSC shall notify the investigator community of important GLAST milestones such as the release of NRAs and the subsequent deadlines, of significant policy changes, and of major advances in the analysis software and techniques.</i>
5.5.1—Suite of Analysis Tools	<i>The GSSC shall provide investigators with a suite of science analysis tools to perform Level 2 processing on Level 1 data.</i>
5.5.1.1—Single Analysis Environment	<i>The GSSC shall provide a single higher level analysis software environment for use by the scientific community and the instrument teams.</i>
5.5.1.2—Software Portability	<i>The analysis tools shall be portable to standard operating systems.</i>



User Support Requirements (4/4)



GSSC-FRD Requirement	Description
5.5.1.3—Vendor Independence	<i>The analysis environment shall respect standards that ensure independence of vendor (i.e., users will be not required to purchase a particular software package to use the environment).</i>
5.5.1.4—Compatibility with Multi-mission Tools	<i>The analysis environment shall respect standards that ensure compatibility with existing multi-mission high-energy astrophysics tools.</i>
5.5.2—Tool Documentation	<i>Relevant documentation about the use, applicability and methodology of these tools shall be provided.</i>
5.5.3—Tool Delivery	<i>These tools and documentation shall be provided through the GSSC's website.</i>
5.5.4—File Format	<i>These tools shall conform to HEASARC standards regarding the use of FITS file formats and keywords.</i>
5.6.4—Web Page Product Generation	<i>The GSSC shall provide, on a regular basis, standard products to be linked to the GSSC's website. Specifically, the GSSC shall calculate and maintain sky exposure maps.</i>
5.7.1.8—Burst Data	<i>The GSSC shall receive GLAST-produced GCN Notices and Circulars from the GCN.</i>



Guest Investigator (GI) Program—Time Periods

- ▶ ***The mission has 3 phases:***
 - *Phase 0—the ~60 day checkout period after launch*
 - *Phase 1—the 1 year sky survey while instrument teams calibrate their instruments. Except for light curves of transients and a small number of strong sources, the data are restricted to the instrument teams.*
 - *Phase 2—the rest of the mission until deorbit. The GI program drives the observations, although survey mode will probably predominate.*

- ▶ ***There will be yearly GI cycles. Cycle 1 and Phase 1 will coincide and only ~a dozen GIs will be selected. ~100 GIs will be selected in each subsequent cycle.***

- ▶ ***A GLAST Fellows Program is planned.***



List of Proposal Preparation Tools

One Tool

ID	Name	Description	Code reuse
S-01a	Source Name Resolver	Resolves standard source names in to coordinates using NED and SIMBAD	Perl scripts available
S-01b	Background Estimator	This tool estimates the background flux from the diffuse Galactic and extra-galactic emission from a given point or region on the sky.	May use SAE code.
S-01c	Exposure Calculator	This tool calculates the rate at which exposure is accumulated (e.g., cm ² -s per day) for a point on the sky. Trade studies will determine whether the exposure accumulation rate depends significantly on the orbit precession phase.	
S-01d	γ PIMMS	This tool calculates the expected count rate for a given source and a given mission. Input may be the source parameters from another mission.	PIMMS
S-01e	Sensitivity Calculator	This tool uses the background, the source count rate and the exposure accumulation rate to calculate the time for a source detection, for significant variability, etc.	
S-02	Exposure Analyzer	Reads in pointing history (FT2) and plots exposure map and history. Can be used to evaluate past, future and proposed observations	May use SAE code.
S-03	Orbit Simulator	Simulates an orbit with an observation plan	SAE's O1 with web interface
S-04	Observation Simulator	Simulates an observation of a given region	SAE's O2, no additional interface
S-05	Simulated spectral analysis A	Permits user to simulate the 1D spectral analysis of a source.	XSPEC, no additional interface
S-06	Simulated spectral analysis B	Permits user to simulate the 3D (spectral+spatial) analysis of a source.	Likelihood, no additional interface
S-07	GBM Simulated Spectral Analysis	Simulates the spectral analysis of a burst observed by the GBM.	XSPEC, no additional interface



The GI Program—Administration

- ▶ *For a February 2007, launch:*
 - *NRA development—10/1/05*
 - *NRA release—5/15/06 (∴ Included in ROSS-06)*
 - *Proposal deadline—8/15/06*
 - *Peer review—11/15/06*
 - *Cycle begins—4/1/07*
- ▶ *GI program administered using standard LHEA procedures (FRD §5.3), e.g., using the OGIP proposal database. Two step proposal process: funding proposal submitted only if science proposal accepted.*
- ▶ *We anticipate that most proposals will only request funding since survey mode will meet most data requirements. This was true for BATSE proposals in the CGRO GI program.*



GI Program Software

- ▶ ***Proposal information will be submitted using OGIP's Remote Proposal System (RPS), customized for GLAST. Target information entered through RPS will ultimately be transferred electronically to the scheduling tool.***
- ▶ ***Proposers will estimate source detectability using tools accessed through the GSSC website.***
 - *Different levels of generality, accuracy and complexity*
 - *Multimission comparisons*
 - *Based on other missions' tools or part of the standard analysis environment*
- ▶ ***Abstracts of successful proposals will be accessed through the BROWSE interface (FRD §5.3.2.9).***



Delivery of the Standard Analysis Environment

- ▶ *Users will analyze data using a set of tools developed for GLAST—the Standard Analysis Environment SAE—FRD §5.5). These tools will run on all FTOOLS-supported platforms, including Windows.*
- ▶ *Users will download the SAE to their servers (FRD §5.5.3) using the HEASARC distribution software for UNIX platforms. A similar methodology will be developed for Windows.*
- ▶ *Initially, the software will be downloaded from the GSSC website (with links from the HEASARC website), while later in the mission it will be downloaded from the HEASARC website (with links from the GSSC website). In the early years of the mission the SAE's update releases will be more frequent than that of the more mature standard FTOOLS suite.*



User Assistance

- ▶ ***Clear documentation (FRD §5.5.2) is crucial for the success of the SAE.***
- ▶ ***In addition to copious on-line documentation, the GSSC will answer user questions through a 'helpdesk' (FRD §5.3.3.3). FAQ extracted from questions.***

ID	Name	Description
S-61	Help Desk Question Submission	Enables users to submit questions about GLAST analysis to the GSSC via a webform.
S-62	Help Desk Response Administration	Transfers the questions submitted via the GSSC helpdesk (S -61) to duty scientists responsible for answering them, tracks the response time, archives subsequent correspondence.
S-63	FAQ Access	Enables the website user to browse and search the list of frequently asked questions compiled from the GSSC helpdesk submissions

- ▶ **This software already exists for S-61 and S-62.**



Posting Mission Results

- ▶ ***Many of the GLAST data products—e.g., Level 1 data and catalogs—will be in databases accessed through BROWSE.***
- ▶ ***The GSSC will post mission results (FRD §5.4.2). Some of these postings are regular products—exposure and count maps (FRD §5.6.4)—that will be created regularly (e.g., weekly, monthly, yearly), while other postings will be triggered by the ingest of the relevant data products.***

ID	Name	Description
S-51	Count Map Generator	Generates count maps. The tool will be run periodically by a software pipeline.
S-52	Exposure Map Generator	Plots the exposure map for the entire sky and select regions. The tool will be run periodically by a software pipeline.
S-53	LAT Diffuse Emission Display	Displays the current diffuse emission model
S-54	GRB Map Display	Creates and displays map of GRB locations
S-55	GRB Lightcurve Display	Displays a lightcurve for each GRB
S-56	GCN Post	Receives, archives and posts on a webpage GLAST GCN Notices and Circulars.



Posting Mission Results, cont.

- ▶ ***TOO approval and results will be posted***
- ▶ ***Every gamma-ray burst will have its own webpage(s) with:***
 - *Lightcurves; posting of the GBM lightcurve will be automated*
 - *All the GLAST-produced GCN Notices and Circulars*
- ▶ ***A map with the burst locations will also be posted.***

ID	Name	Description
S-51	Count Map Generator	Generates count maps. The tool will be run periodically by a software pipeline.
S-52	Exposure Map Generator	Plots the exposure map for the entire sky and select regions. The tool will be run periodically by a software pipeline.
S-53	LAT Diffuse Emission Display	Displays the current diffuse emission model
S-54	GRB Map Display	Creates and displays map of GRB locations
S-55	GRB Lightcurve Display	Displays a lightcurve for each GRB
S-56	GCN Post	Receives, archives and posts on a webpage GLAST GCN Notices and Circulars.



Posting Timelines

- ▶ ***The GSSC will post past and future timelines (FRD §5.4.1.3):***
 - *Annual science timelines (planned observations for 1 year with 1 week resolution)*
 - *Preliminary science timelines (covers 1 week, created ~month in advance)*
 - *Final science timelines (covers 1 week, created a few days in advance)*
 - *As-flown timelines (covers 1 week).*
- ▶ ***Ingest of these timelines will trigger the posting; therefore the latency should be hours.***
- ▶ ***The GSSC will also have a tool that will display the timelines graphically (S-02). Since the timelines cover the past and the future, scientists can determine when a source was or will be observed, and with how much exposure.***



Schedule—Drivers

- ▶ ***The GI program is the driver for the User Support tools:***
 - *The proposal submission tool, the helpdesk tools, and the proposal preparation tools must be ready when the NRA is released*
(L-10.5 month = mid-May 2006 ⇒ GSSC Release 6 on 4/3/06)
 - *The display tools are not required until there are data after launch (GSSC Release 7 on 1/31/07).*
- ▶ ***If tools are ready before their release date, they may be used in the GRTs; their availability when the corresponding simulated data are ingested would be a nice touch.***
- ▶ ***Many of the user support tools use existing tools.***
- ▶ ***User Support will require a great deal of text.***



GSSC User Support: Summary

- ▶ *The GSSC will administer the GI program using standard OGIP procedures.*
- ▶ *The proposal preparation tools will build on existing tools.*
- ▶ *Investigators will download the analysis tools through the GSSC website. The GSSC will provide documentation and a helpdesk to assist investigators.*
- ▶ *The GSSC will post mission results on its website.*
- ▶ *The user support tools do not have to be ready until the first NRA is released, but web posting tools may be ready for the GRTs.*



GSSC Testing

Tom Stephens
tstephen@milkyway.gsfc.nasa.gov



Verification Matrix

- ▶ ***The GSSC maintains a Verification Matrix (GSSC-0002) tracking the compliance with its requirements.***
- ▶ ***The GSSC CCB will note requirement verifications in the Verification Matrix Document.***
- ▶ ***Because most of the requirements that will be verified by tests involve software, most of the GSSC Test Plan (GSSC-0005) focuses on software.***
- ▶ ***Hierarchical testing: unit tests before sub-system tests before system tests.***
- ▶ ***At each stage, internal GSSC tests will precede relevant GRT.***



Test Personnel

► **GSSC Test Manager**

- *Appointed by the GSSC Manager*
- *Manages design and implementation of tests*
- *Ensures tests are used consistently on an on-going basis*
- *Tracks test results*

► **GSSC Test Teams**

- *Appointed by GSSC Test Manager for a specific set of tests*
- *Members are selected from GSSC staff and will exclude the author of the software being developed if possible.*
- **Test Team Lead**
 - *Organizes Test Team's activities*
 - *Insures that test report is drafted and submitted on time*
 - *Cannot be the author of the software being tested*



Testing Procedures I

- ▶ **Test Preparation**
 - *Test goals defined, detailed test plan and list of test cases prepared*
 - *Identify software and hardware needed for test*
 - *Prepare test input data*
- ▶ **Configure and Build Software**
 - *Download, install and configure software to be tested*
- ▶ **Test Execution**
 - *Individual tests and regression testing performed*
 - *Identify any errors or problems*
- ▶ **Initial Test Report**
 - *Test failures*
 - *Issues to be resolved*
 - *Recommended solutions*



Testing Procedures II

- ▶ **Issue Resolution**
 - *Problems documented in GSSC Issue Tracking System and managed by Test Team Lead.*
 - *Issue closed at next test*
- ▶ **Retesting of Software**
 - *As issues are closed the Test Team will retest the affected software to verify that the issue has been successfully resolved*
 - *Results of rerun test to be included in final report*
- ▶ **Final Test Report**
 - *Description of hardware and software used and all tests performed (data files used included as appendices for future testing)*
 - *Test objectives met, requirements satisfied by test*
 - *Issues raised and their resolution*
 - *Recommendations for system improvement*
- ▶ **Software Release**
 - *Once all tests are passed the software is certified for release*
 - *All future changes under control of CCB*



Discrepancy Management I

► *Issue Tracking*

- *All errors or discrepancies found during testing will be entered into the GSSC's Issue Tracking System.*
- *Any recommended software enhancements or modifications will also be entered into the Issue Tracking System*

► *Issue Assignment*

- *Responsibility assigned by*
 - *Software Manager – New, unreleased software*
 - *CCB – Previously released software*
- *Assigns criticality to each issue*
- *Assigns responsibility for resolution to GSSC staff members, usually the original developer*



Discrepancy Management II

- ▶ ***Issue resolution***
 - *Required before the software passes the test*
 - *At least 1 week before the scheduled release date*
- ▶ ***Reporting***
 - *Responsible party submits report detailing steps taken and code changes made to resolve issue.*
 - *Incorporated in final testing report*
- ▶ ***Issue Closure when software passes retest***
 - *Issue marked as resolved by the Test Manager*
 - *Officially closed by the CCB or Software Manager*



Unit Test Specifications

- ▶ **Purpose**
 - *These test the basic functionality of individual software components and verify that the functional requirements of the individual components are met.*
 - *Focus on correct operation and robustness in the presence of valid, invalid and incomplete data input.*
- ▶ **Performed as needed to prepare software for larger system or end-to-end tests and as part of natural development cycle.**
- ▶ **Test code and data will be provided by the developers and distributed with the individual components.**
- ▶ **Nightly builds and execution of test software performed on each component.**
- ▶ **No formal reports generated**



Subsystem Test Specifications

- ▶ ***Purpose—test the larger software subsystems, inter-system communications and subsystem performance. Tests include:***
 - *Analysis of data volume*
 - *Analysis of throughput capabilities*
 - *Response time of various systems.*
- ▶ ***Conducted by GSSC Software Test Teams (GSTT)***
- ▶ ***Performed as delimited in GSSC Test Plan to verify functionality and performance in preparation for software releases and system tests.***



System Test Specifications

- ▶ ***Purpose—test the operation of the GSSC systems as a whole in real world scenarios that include interaction with ground system elements outside of the GSSC.***
- ▶ ***Conducted by GSTT and other Ground System elements***
- ▶ ***All GSSC systems involved in the System tests are tested informally in preparation for the formal test.***
- ▶ ***Scheduled as needed to meet deadlines defined in the Mission Schedule***
- ▶ ***Many System tests already scheduled***
 - ***GSSC System Tests***
 - ***Ground Readiness Tests (GRT)***
 - ***End-to-End Tests***
 - ***LAT Data Challenges***



GSSC System Test Schedule

- ▶ ***The primary GSSC System Tests (GST) are tied to the software releases presented previously***
 - *GST1 (10/01/04) – tied to Software Release 1 (11/15/04)*
 - *GST2 (12/15/04) – tied to Software Release 2 (02/01/05)*
 - *GST3 (03/15/05) – tied to Software Release 3 (05/01/05)*
 - *GST4 (06/15/05) – tied to Software Release 4 (08/01/05)*
 - *GST5 (12/15/05) – tied to Software Release 5 (01/31/06)*
 - *GST6 (02/20/06) – tied to Software Release 6 (04/03/06)*
 - *GST7 (12/04/06) – tied to Software Release 7 (01/15/07)*
- ▶ ***Many of the systems will be tested informally much earlier than their formal tests – e.g. prototype D1 and D2 database systems were tested from Dec. '03 – Feb. '04 as part of a LAT Data Challenge although not formally tested and released until GST4.***



GSSC Testing: Summary

- ▶ *Requirement verification is tracked by a Verification Matrix*
- ▶ *The GSSC Test Plan document has been baselined*
- ▶ *Most GSSC requirements that can be tested involve software; therefore the GSSC test plan deals predominantly with software*
- ▶ *Testing is an integral part of component development*
- ▶ *Unit level testing is already well underway for those components currently under development*
- ▶ *System level testing will occur prior to the GRTs and ETEs; compliance with GSSC requirements will be documented in these System tests*